INSTRUCTIONS FOR MODEL 201A & 251A SIGNAL TRACER

PRECISION ELECTRONICS, INC.

9101 KING STREET • FRANKLIN PARK, ILLINOIS

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PRECISION ELECTRONICS, INC.
641-643 MILWAUKEE AVE.
CHICAGO 22, ILL.

Model 251A Deluxe Signal Tracer

Reference Data.

A. Power requirements.
   1. 105-125v AC 50-60 cps.
   2. Power consumption 35 watts.

B. Isolation
   1. Specially designed electrostatically shielded power transformer isolates unit from AC line for safe use on AC-DC equipment.

C. Input impedance.
   1. Probe is 4 megohms shunted by 2mmf. at low frequencies. The input resistance decreases with increasing frequency caused by dielectric losses.
   2. Audio input impedance is ½ meg. on x100 position, and .25 meg. on x1.

D. Frequency response.
   1. Probe from 20 cps. to over 300mc.
      Note: When probe is used on audio frequencies a slight signal distortion in speaker is normal.
   2. Audio inputs from 20 cps. to over 20,000 cps.

E. Response characteristics.
   1. Audio input to meter x1 position flat within .1 of one db. from 30 cps. to 20,000 cps.
   2. In x100 position plus or minus ½ db. from 50 cps. to 10,000 cps.
   3. Probe flat within 1 db. from 20,000 cps. to 100 mc. approx. Above 100 mc. the curve depends on the resonance of the ground lead circuit tuned by its length.

F. Sensitivity.
   1. Probe is 1½ microvolts for full scale deflection.
   2. Audio x1 is 5 volts for full scale deflection.
   3. Audio x100 is .6 volt for full scale deflection.

G. Tube complement.
   1. 6AQ6/6AT6 high gain triode in probe, 6SJ7 pentode amplifier, 6K6GT power output, 6SN7GT VTVM, 6X5GT rectifier.
   2. Standard tubes may be used for replacement.

H. Size and Weight.
   1. 6½D X 12¼W X 9H shipping weight 12 lbs.

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OPERATION MODEL 201A SIGNAL TRACER.

1. Unpack carefully and inspect instrument for possible damage.
2. Plug power cord into 117v AC receptacle.
3. Slide power cord switch to on position, pilot light illuminates.
4. Let PROBE-AUDIO switch to PROBE position, allow three minute warm-up.
5. Unclip ground lead and touch probe tip with finger. Raise gain control until loud hum is heard.
6. Instrument is now ready for use.

Reference data

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   1. 105-125 volts AC 50-60 cps.
   2. Power consumption 35 watts.

B. ISOLATION.
   1. Specially designed electrostatically shielded power transformer isolates unit from AC line for safe use on AC-DC equipment.

C. INPUT IMPEDANCE.
   1. Probe is 4 megohms shunted by 2 mmf. at low frequencies. The input resistance decreases with increasing frequency caused by dielectric losses.
   2. Audio input impedance is ½ megohm.

D. FREQUENCY RESPONSE.
   1. Probe from 20 cps to well over 300 mc. NOTE: When probe is used on audio frequency circuits a slight distortion in speaker is normal, due to the re-rectification.

E. RESPONSE CHARACTERISTICS.
   1. Audio input to meter jack is substantially flat, within .1 of 1 db., from 30 cps to 20,000 cps.
   2. Probe flat from 20,000 cps. to 110 mc. The curve depends on the ground lead circuit, tuned by its length.

F. SENSITIVITY EXPRESSED AS GAIN.
   1. Probe input of 1 microvolt, gives an output of 12 volts at meter jack, 12,000 gain.
   2. Audio input jack, 80 db gain.

G. TUBE COMPLEMENT.
   1. 6AQ6/6AT6 high gain triode in probe, 6SJ7 pentode amplifier, 6K6 power output, 6X5 rectifier.

The Model 201A SUPER TRACER is an instrument that enables the operator to "listen in" on any part of a circuit and instantly locate the point at which a signal is distorted or interrupted.

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The student or beginner will learn general circuit theory and function of successive stages of a receiver, and the service engineer who is well grounded in theory will learn a faster method of locating defects than is possible by any other method.

Any person doing servicing should learn to think in terms of the signal and not in terms of just voltage, resistance, capacitance, or inductance. Any of these are just a single factor in many that are necessary to proper transfer of the signal. No one can possibly learn or remember all the gradations of these factors and their correct relationship to each other in all circuits present in all equipment that an average man should be able to competently repair today.

The signal, and the signal alone, is really the only thing that matters. Many circuits such as AVC and AFC require the signal as the actuating force for them to work. In other words, if only individual factors are checked without knowledge as to signal presence, such circuits will be found to be perfect and all the wasted time will not have resulted in any practical finding necessary to repair the unit. Single volt-ohm-capacitance tests are static and interfere with the operation of the receiver. This expenditure of energy wastes time and requires enormous effort to translate readings into circuit effects and the into surmised operation. Too much chance for error occurs in analysis, and such cumbersome technique is costly for anyone who does not employ signal tracing as the means of locating the defect. Realize that the signal is the most important element in the circuit, as both the actuating impulse and as that which is being controlled.

Successful servicing requires speedy location of the defect. Whether it is a complex circuit or a simple one, the point at which the signal becomes distortion or interrupted, can be found with a signal tracer in a matter of minutes. It is simple to substitute parts in that PARTICULAR CIRCUIT until normal operation is restored. Analysis is not always necessary, altho a person will grow in experience and be able to spot a defective component at the located point of trouble in the circuit, thus saving time which is money.

SIGNAL TRACING APPLIED TO A TYPICAL RECEIVER

The first step, necessary in servicing all electronic equipment by any method, is to determine if the unit under test has current and is energized with the proper supply voltage. Of course, if there is a "dead short" in the power circuit or excessive overheating of any component, this obviously must be corrected before other tests can be of value; first to prevent damage to the equipment, and second to put it into some resemblance of the normal operating state. Tube filaments should have power, and B plus should be present.

NOTE: In AC-DC circuits which have tube filaments wired in series, an open filament anywhere will keep all tubes from lighting. The Signal Tracer offers a speedy method to locate the defective filament.

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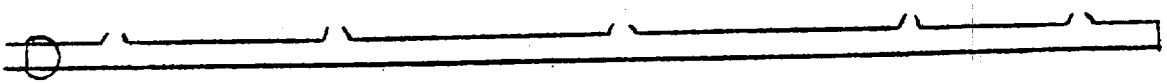
Fasten the ground lead clip of the probe to the negative side of the filter condensers in the power supply and touch the probe tip to each of the tube filament connections in turn. (The PROBE-AUDIO switch is in PROBE position and the GAIN control is turned up slightly.) The tube with the open filament will cause a hum in the Signal Tracer speaker on one filament connection only. All other tubes will either hum on both filament connections, or will not hum on either.

THESE WILL HUM ON BOTH FILAMENT PINS.	HUM ON ONE SIDE OPEN FILAMENT.	NO HUM ON EITHER SIDE.



NOW TO BEGIN

a. Once the power supply and filaments are known to be functioning, tune the receivor to a station. The Precision Electronics Signal Tracers are so sensitivo that regular broadcast stations are recommendod as a source of test signals.
b. If there is no apparent signal from the receiver speaker, you are only interested in locating at what point the signal is interrupted.
c. If the receiver output is weak, you will look for the stage where normal expected gain in signal strength does not occur.
d. If the receiver spoaker sounds distorted, noisy, or hums; you will look for the place where such irregularity first occurs.
e. Intermittent operation or distortion requires waiting until it occurs before proceeding. Further explanation later in this book.

REFER TO FIGURE 1. Proceed to check from the antenna stage thru the output stage the grid and plate connections of each stage until the point at which the signal becomes distorted or interrupted is located. Use a tube handbook to find tube base connection numbers for the various grid and plate pins if you are unsure.

Figure 1 is practically speaking a standard AC-DC circuit which will be often encountered in servicing. Minor differences may occur, but the signal tracing TECHNIQUE remains the same.

NOTE: The ground lead on the probe is purposely short. It may be necessary to move the ground clip to a convenient point on the chassis or B- as you progress thru a large chassis, or an added length of 12 inches or so may be added to make testing more convenient. This ground lead length is satisfactory when checking standard broadcast receivers for all RF, IF, or audio frequencies. For high frequencies found in FM and TV, the ground lead length should be the length of the ground lead circuit tuned by its length.

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Now we are going to take you thru an AC receiver circuit at length to give you an analysis of circuit troubles and how to find them with the Signal Tracer. Figure 2 is a typical AC superheterodyne receiver chosen for explanation.

After the power supply and tube filaments are functioning, we are ready to find the "genuine complaint". The principal signal test points are lettered consecutively in the order they are to be analyzed while following the signal path. A resume of the faults that may be observed are listed for each test point, as well as the results that may be expected at each stage of the receiver.

CONVERTER and OSCILLATOR CIRCUIT.

Connect the ground clip to the chassis or B-. (You have turned the receiver ON and ascertained the power supply is functioning, set the receiver volume control to a minimum, and tune the receiver to where a strong local station should be heard. Signal Tracer is ON, and GAIN control is turned up about two-thirds.)

Touch the probe tip to point "A" on the partial diagram, Figure2a. A jumble of stations should be heard, depending on your location, of course.

Next touch point "B". Receiver dial may have to be rotated slightly to pick up the signal perfectly at this point. If the antenna system and the tuning condenser are functioning properly the broadcast station may be heard clearly and with ample volume from the Signal Tracer speaker.
Lack of signal indicates an open or shorted to ground antenna coil or loop, a short-circuited tuning condenser (rotors touching stators), or a shorted shunt trimmer. Turning the dial may show a station signal elsewhere indicating a rotor-stator short at only one point.
A weak signal indicates an open tuning condenser circuit or trimmer, partially shorted antenna coil secondary, or an open .05 AVC filter condenser.

Next place probe at point "C". No or very weak signal is normal, but an appreciable signal shows .05 condenser to be open.

Point "D" If signal is present, .1 mf condenser is open.

NOTE: You may plug your VTVM into the OUTPUT METER jack of the Model 201A. The Model 251 and 251A has a built in meter. The composite instruments can then be used as a sensitive AC VTVM. A scope may be connected to the same jack.

Place probe back to point "B". Adjust meter and listen to speaker to get a level for reference. Now move probe to point "F", the plate or output section of the converter tube. A definite increase in signal strength and meter reading should be noted due to the normal conversion gain of the first stage, and the Signal Tracer Gain control will have to be reduced to a usable level.

No signal at point "F" where a signal was present at point "B" indicates: defective tube, open IF transformer primary, shorted trimmer, no plate voltage, shorted screen condenser, or open cathode circuit to ground. A WEAKER signal than point "B" indicates: defective tube, open or misaligned IF primary trimmer, no screen voltage, leaky filter condenser, oscillator inoperative or misaligned, or partial fault in cathode circuit. DISTORTION shows trouble with the screen bypass or filter condenser, again a defective tube, or cathode circuit trouble.

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CAUTION: Do NOT move alignment trimmer adjustments until ALL OTHER sources of trouble have been thoroughly investigated and eliminated as the cause of improper operation. Make sure the set has not been tampered with or circuits purposely changed.

Point "E" (stator of oscillator tuning condenser) is the next and very important test point. Hold probe at this pont "E" and turn off receiver. Turn it on immediately and a THUMP heard in the Signal Tracer speaker shows that the oscillator circuit is working. A swing of the meter pointer will also be noted on the Model 251A or on meter connected to Model 201A. Some practice is advised by the new user on a set that is operating perfectly so that the THUMP and sudden swing can be recognized in the future.

Point "G", no signal is normal, if appreciable signal filter is open.

IF AMPLIFIER AND SECOND DETECTOR. We now progress to the next diagram, 2b. Check signal at point "A", the IF amplifier control grid. No gain from previous point "F" or even slight loss is to be expected because the gain in the transformer may be less than 1. No signal indicates open or shorted IF transformer secondary or shorted trimmer. A WEAK signal indicates open or misaligned trimmer, partial open or short in IF transformer secondary, or open .05 mfd. condenser. (point "B")

Next check point "B". No signal is normal, appreciable signal shows open filter.

Place probe at point "A". Adjust meter and speaker to get a reference level. Now check point "C". A good increase in signal is normal. NO signal indicates: defective tube, shorted trimmer, shorted or open IF transformer primary, or no plate voltage present. WEAKsignal shows: defective tube, open or misaligned trimmer, partial open or short in transformer primary, low plate voltage, or trouble in cathode circuit.

NOTE: If the probe picks up a certain amount of unfiltered AC ripple from this "B" plus point, it is wise to hold the probe tip close to, but not touching, the plate connection. This checks distortion if present, but actually contact the plate connection to check for gain in signal strength.

Next place probe at the detector diode, point "B". No gain or perhaps a slight loss is normal because the transformer secondary is is looking into a low impedance tube input.
NO signal indicates an open transformer secondary, or a shorted trimmer here. A WEAK signal here indicates a partially open or partially shorted transformer secondary, open or misaligned trimmer, or open or shorted RF bypass condenser.

Signal at point "E" next should be about the same as point "D". Point "E" or AVC diode test shows how the diode coupling condenser is working. NO SIGNAL means the condenser is probably open, thus accounting for no AVC action.

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SOME TIPS ON AVC

If no signal was present at point "E" there will be no AVC voltage, because AVC voltage is derived from the rectifying or detector action of the second detector portion of the tube. The negative AVC voltage derived is fed back to the control grids of the previous tubes to supply them with controlled grid bias. Therefore do not overlook the AVC circuit if a defective signal has been noted at one of these grids. Lack of, or too great an AVC bias voltage on the grid can cause distortion. Improperly filtered A VC due to defective condensers or resistors in the AVC circuit often result in a weak signal, oscillation, or distortion. By all means check the AVC circuit filter condensers and resistors for proper value.

Point "F" next, touch first point where the detected or audio signal appears. NO signal indicates defective diode section of the detector tube, or shorted Rf bypass condenser. A WEAK signal may be, defective tube, shorted condenser at volume control, open resistor at this point, or open volume control. Distortion may be caused by a partial open or short in these components.

Point "G", the volume control is next. No signal indicates open resistor, or shorted bypass condenser at this point.

SOME TIPS ON VOLUME CONTROLS.

The signal reaches the first audio grid thru the volume control. Since controls are a frequent source of trouble it is advised that you always check the control for noise, roughness, or opens; which often cause distortion, blaring, or intermittent operation. Place the probe on the arm contact of the control and slowly rotate it thru its full range several times. The volume should increase and decrease smoothly without breaks, scratch,or noise. If not replace control.

FIRST AUDIO AND OUTPUT STAGES. Refer to the next diagram,2c.

Point "A", the arm connection of the control is explained above.

Point "B", the first audio grid, has its level determined by the setting of the receiver volume control, With control on full, the signal should be as loud as point "D" previous, the detector diode. NO signal would show the coupling condenser to be open.

Point "C". Any appreciable signal shows bias filter condenser is open.

Again take a reference level at point "B". Now place probe at point "D", the first audio plate. Substantial gain should be noted.

NOTE: Once you have been satisfied with the gain at point "B", you should then set the receiver volume control just high enough to get a good signal in the Signal Tracer speaker with the Signal Tracer GAIN control set fairly low. Otherwise, with the Signal Tracer volume control set at a high level to pick up a signal which has been greatly cut down by the receiver volume control, the Signal Tracer will amplify any hum present along with the weak signal. By setting the receiver volume control just high enough to over-ride any grid hum, the Signal Tracer can pick up a quality signal without hum.

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NO signal at point "D" shows: Bad triode section of tube, no plate voltage, or open plate resistor. WEAK signal indicates: poor tube or partially open plate resistor. NOISY signal indicates: poor tube, defective plate resistor.

NOTE: When checking with the probe in the audio section a slight signal distortion is normal due to re-rectification of the signal. For quality tests, it is recommended that an audio probe made simply from a piece of shielded cable with appropiate probe tips, be plugged into the AUDIO INPUT jack and the PROBE-AUDIO switch be set at the AUDIO position. A condenser in series with the hot lead of the probe from .01 to .1 is recommended.

The use of the word "probe" in the following denotes either the regular or the audio probe.

Place probe at point "E", the output amplifier grid. Signal should equal point "D". NO signal indicates open coupling condenser at first audio plate.

Set reference level at point "E". Now probe at point "F", the output amplifier plate, and a definite gain in signal should occur. NO signal indicates; defective tube, shorted bypass, open output transformer winding, open coupling condenser, or no plate voltage supply, WEAK signal shows: defective tube, lack of bias voltage, leaky coupling or by-pass condenser, partially shorted output transformer, or shorted output tranformer secondary.

Now place probe at point "H", signal strength should be much lower than at point "F" because of low impedance condition. A weak or distorted signal indicates trouble in the speaker or output transformer secondary winding which is easily determined.

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The SIGNAL TRACER is an all around instrument that is so ingenious in its many and varied applications it actually replaces the need for otner servicing instruments. Many of our users tell us that a tube checker is not a necessity after they acquired a signal tracer. All elements of a tube can be checked while the tube is actually operating in the circuit for which it was designed, and the signal tracer gives an authorative result. It will easily detect a weak, gassy, or noisy condition, Loose elements, shorts, a non-oscillator, or a low gain tube are speedily ascertained with a signal tracer. No other tube testing method can possibly compare.

To check the output of magnetic pickups, use the probe input. Use Audio input for checking crystal pickups and microphones.

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ALIGNMENT OF F.M. RECEIVERS

Alignment is the most important factor in the servicing of F.M. receivers, because a receiver will function perfectly only when it is correctly aligned. Many manufacturers, in their service notes, consider the I.F. and limiter alignment in a over-all procedure. For example, the SIGNAL TRACER to be used is placed in the proper limiter grid circuit, the signal generator output is connected to the R.F. grid input of the converter or mixer tube, and the frequency is adjusted to the I.F. of the receiver. Turn on modulator on the R.F. generator. With these two instruments remaining in position, the very last I.F. transformer, including any between two cascaded limiters, is aligned first for maximum output. The meter on Model 251A, will give an excellent indication. The speaker on the 201A will suffice for this operation.
The other I.F. transformers are then aligned, working from the back to the front of the receiver in the same manner. The signal generator's output should always be kept at a minimum, to keep from saturating the limiters. If they do, the tuning adjustments will be very broad and it will be difficult to find the true resonant position of the I.F. transformers.
Now move Signal Tracer to the output of discriminator. Tune the primary of the discriminator for maximum output. Then tune secondary for a null. This completes the alignment.

For best results slip speghetti over probe tip, to keep from loading circuit.

Expressed in its simplest terms, the sequence of signal tracing is as follows: Signal is traced through the receiver until some point is reached where it is no longer normal. Supplementary tests are made at the point where the signal departs from normal. Usually the tests include voltage and resistance checks of the various components in the faulty circuit.

OTHER APPLICATIONS FOR SIGNAL TRACER

a. Field strength meter. By use of T.V. booster worked with antenna under observation.
b. Checking electric blankets. Connect Tracer to one side of line, thru a condenser, and run up and down elements for either no hum, indicates open, and the presence of hum indicates the other side of A.C.
c. Noise detector. Connect crystal microphone to probe input. Such as a valve manufacturer use to check noise level of various valves. Using 251A, meter gives relative noise level under extreme sensitivity.
Also valuable in locating noise in automobile installations. Use extension cord on Tracer and run Probe up and down all wiring, to find source of pick-up noise. Bypassing with various condensers will decrease noise to low level.
For locating man made radio noises. Turn up gain on Signal Tracer and probe will act as noise locater in short order.
d. By using as tube tester. (Tubes in operation) The whole story is revealed as to what goes on inside a radio tube: noise, gain, intermittant shorts, fading and etc., by placing probe on various elements of tube.

The versatility of the Precision Electronics Super-Tracer is such that its uses are only limited by the ability and imagination of the operator.

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SERVICING TELEVISION RECEIVERS WITH SIGNAL TRACER

Television receivers, in their present state of development, are critical mechanisms that require accurately adjusted circuits if the maximum enjoyment is to be derived.

When the action of the cathode-ray tube is analyzed, it is found to be the recipient of voltages from four different sections of the receiver. They include:

1. Horizontal deflection circuits
2. Vertical deflection circuits
3. Video circuits
4. The power supply - both high and low-voltage units.

Although the final image, as seen on the viewing screen, represents a combination of these four voltages, each voltage has certain definite characteristics that enables the viewer to identify the particular section at fault.

HORIZONTAL DEFLECTION CIRCUIT.

The purpose of the entire horizontal deflection system is to provide saw-tooth voltages or currents that force the electron beam to move from side to side.
The synchronizing pulses contained in the incoming signal keeps the frequency of the horizontal deflection voltages at a value determined at the transmitter. Any distortion becomes immediately apparent on the viewing screen.
The most positive indication of complete failure of horizontal deflection circuits is the appearance of merely a vertical line on the screen of the viewing tube. With the aid of the Signal Tracer, it is possible to locate the point at which the signal is interrupted.

NOTE: An oscilloscope can be connected to the meter out-put jack on MODEL 201A. On MODEL 251A, the scope is connected to the Audio jack, with selector switch in probe position.

Usually, there will be at least two stages in the horizontal section, the oscillator and amplifier. Place the probe on plate of the oscillator tube. If the circuit is functioning, a high frequency whistle will be heard from Signal Tracer speaker. Frequency of this signal is 15,750 cps. If using Model 251A. this signal will give indication on the meter. The scope may be used with the Tracer at this point. In some instances, the human ear cannot hear this high frequency, in which case one of the last two methods mentioned be used. If NO signal, the components in this circuit should be checked. Now let us assume that the oscillator is working.
Place probe on the grid of the horizontal amplifier tube. If scope is used, a waveform similar to Fig. 4 will be observed.
Thw voltage of the horizontal amplifier plate will be about 6000 volts, AC. DO NOT CONNECT PROBE TO THIS POINT. Instead, place probe near the plate lead or near the fly-back transformer and the 15,750 cps. signal should be present in the Signal Tracer speaker. An increase in amplitude should be noted.
Refering to Fig. 5. This waveform was observed on the scope, by holding Signal Tracer probe near fly-back transformer. The signal is radiated by the transformer.

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VERTICAL DEFLECTION SYSTEM

Due to the similarity of the two deflecting systems, many of the defects arise in both. The only difference in the present case is that now the image is affected in a vertical direction.

Start at the blocking oscillator or multivibrator oscillator and progress by stages toward the picture tube of the receiver.

Place the Tracer probe on the plate of the vertical oscillator. If circuit is operating properly, an audio frequency of about 60 cps. should be heard through Signal Tracer speaker. As before, this can be observed on the meter of MODEL 251A or on the scope. Refer to Fig. 6. This waveform represents the signal that is developed in the plate circuit of the vertical oscillator, when using the scope in conjunction with the signal tracer.
Next, place the probe on the plate, or near the plate lead, of the vertical amplifier, the same 60 cps signal should be heard from the Tracer speaker. Refer to Fig. 7. This waveform represents the signal on the scope at this point. NOTE that the amplitude is increased and the signal is inverted in polarity.

VIDEO CIRCUITS.

When working on video circuits, DO NOT lengthen the gound lead of the probe. Tune receiver to a station and advance the contrast control to near maximum. Place probe directly on plate of last video amplifier. A low frequency noise will be heard from Signal Tracer speaker. The vertical sync pulses and the video will be heard at the same time.
Fig. 3 shows waveform on the scope, when used with Tracer, at this point. The same procedure can be used on the preceeding video stages, up to the video detector. The signal passing thru the video IF amplifier is a radio frequency. The best results can be obtained by putting the probe across the cathode resistor of each stage, working from the video detector toward the front of the set.
The cathode circuit is at a very low impedance and therefore using the probe will not detune the circuit. Approximately the same waveform as shown in Fig. 3, will be observed on scope which MUST be connected to the Signal Tracer. By doing this, the RF is rectified and amplified in the probe and applied to the vertical plates of the oscilloscope.

The Signal Tracer can also be used in the Sync Circuits.
Place probe on plate sync clipper, DC restorer, and sync amplifier. At each of these points a low frequency sound should be heard through Signal Tracer speaker. This is a 60 cycle frequency.

The audio portion of the T.V. receiver can be serviced with the data covering F.M., given previously.

A little experience and the use of a Signal Tracer, will prove to be a big time saving device for servicing T.V. receivers. Even with the complex circuits found in these receivers, it is possible to single out the stage which interrupts the signal, in the shortest time.

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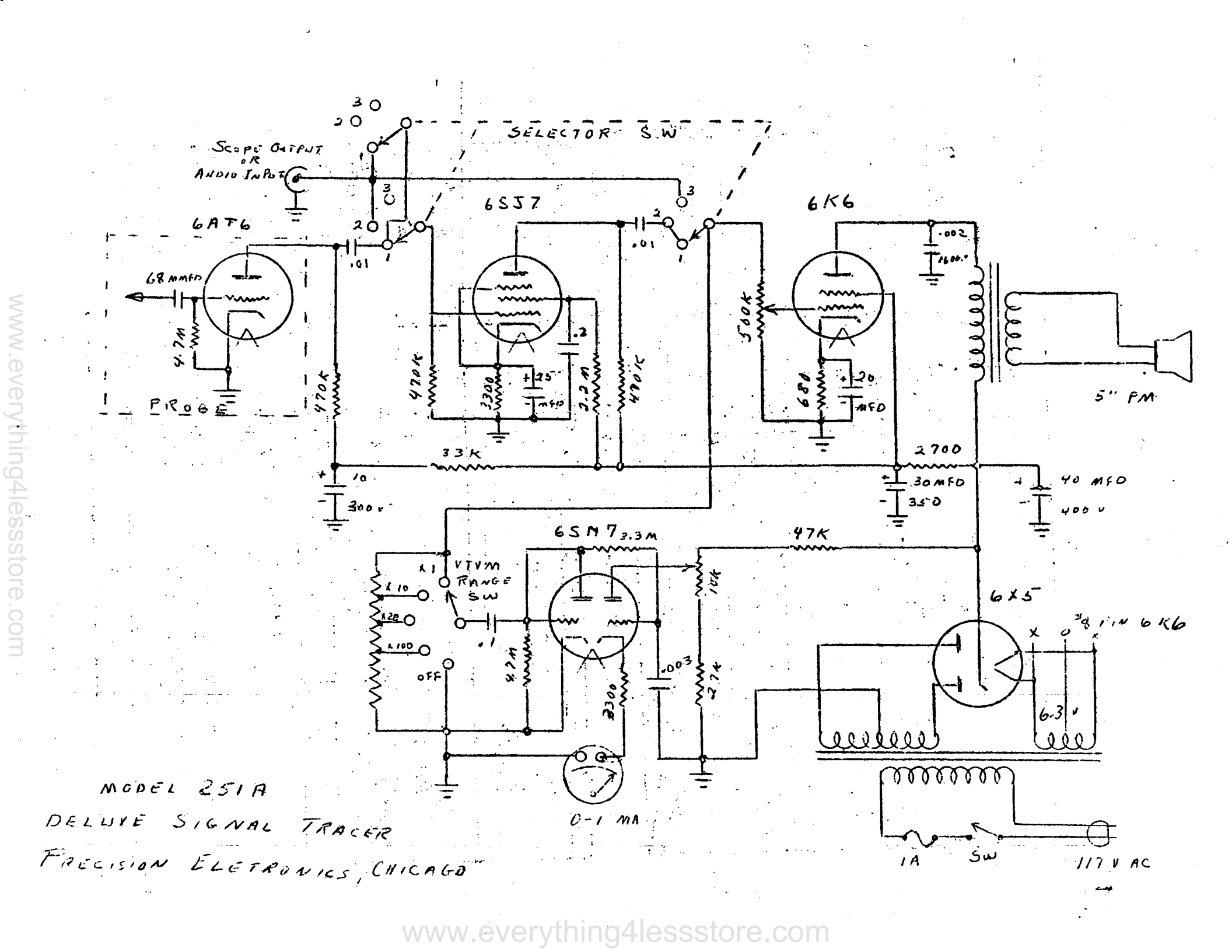

MODEL 251A

DELUXE SIGNAL TRACER

PRECISION ELECTRONICS, CHICAGO

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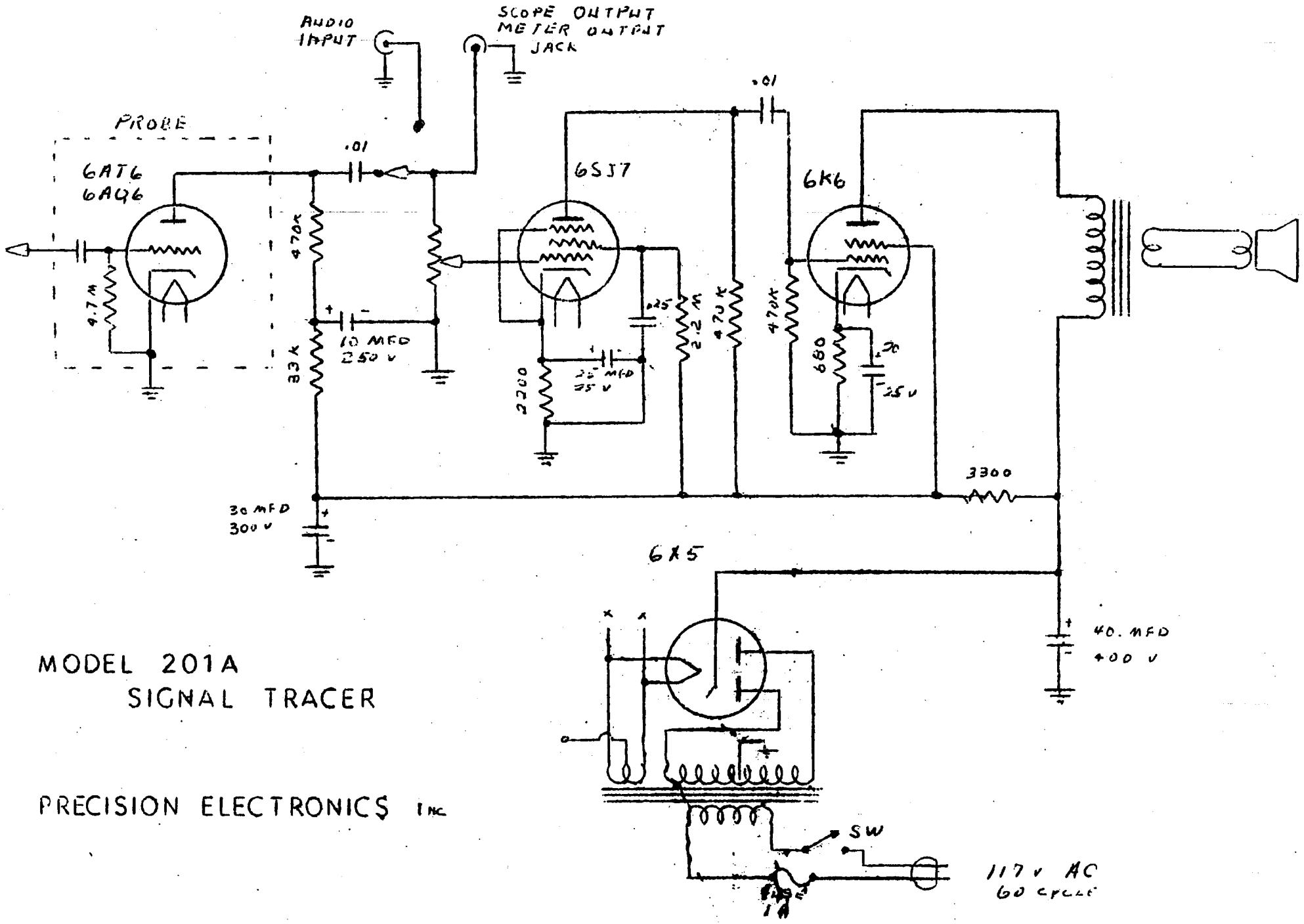

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SIGNAL TRACER

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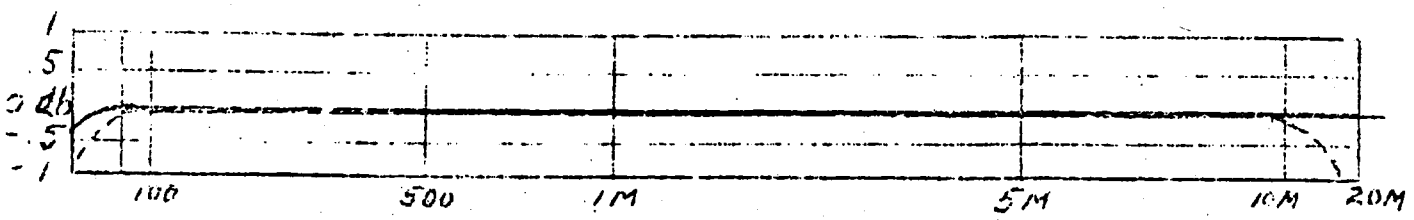
Frequency thru Audio Input

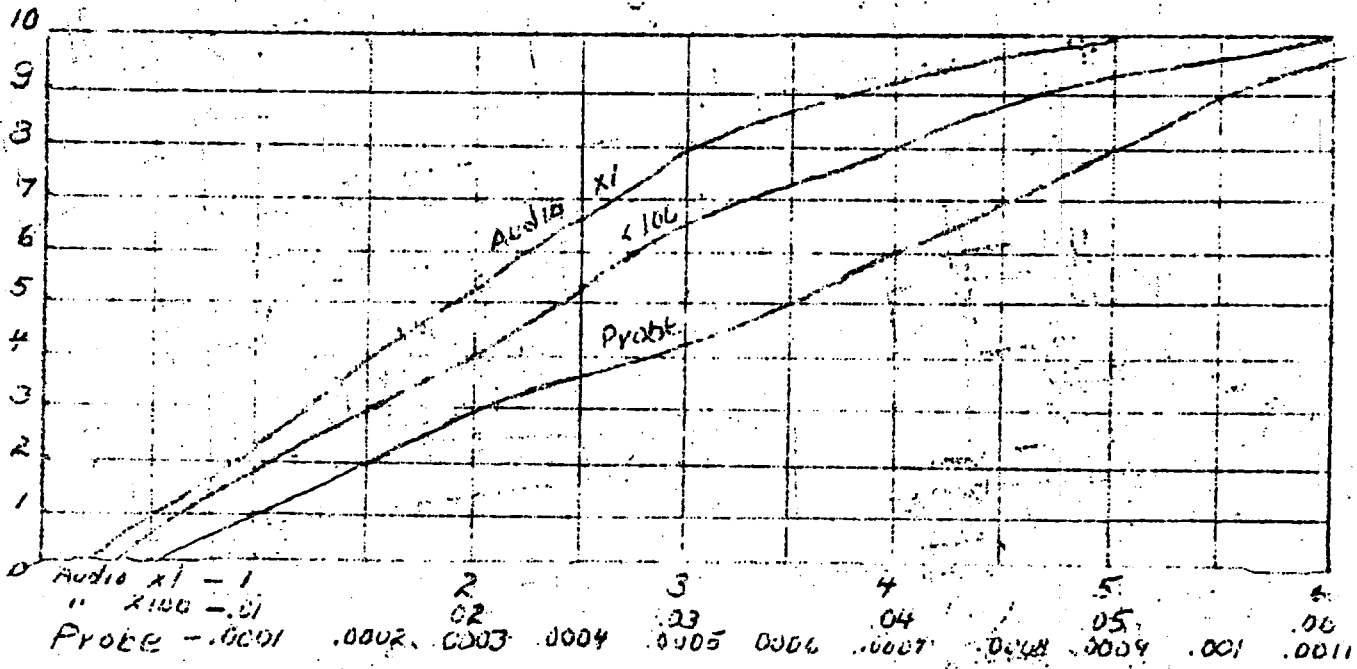


x1 position – Flat within .1 of 1db 30cps to 20,000 cps.
x100 " Flat within ±.5 db 50cps. to 10.000 cps.

Model 251 Voltage Chart

Meter	Audio Input		Probe
Scale	x1	x100	x1
1	.5 volts	.006 volts	.0001 volts
2	.9	.01	.0002
3	1.25	.015	.0003
4	1.5	.02	.00045
5	2.	.024	.0006
6	2.25	.028	.0007
7	2.75	.3	.0008
8	3.	.04	.0009
9	3.8	.04	.001
10	5.	.06	.0015
CHECK APPROVAL	L.C.McG.	AL.H.	W.S.G.

Voltage Graph



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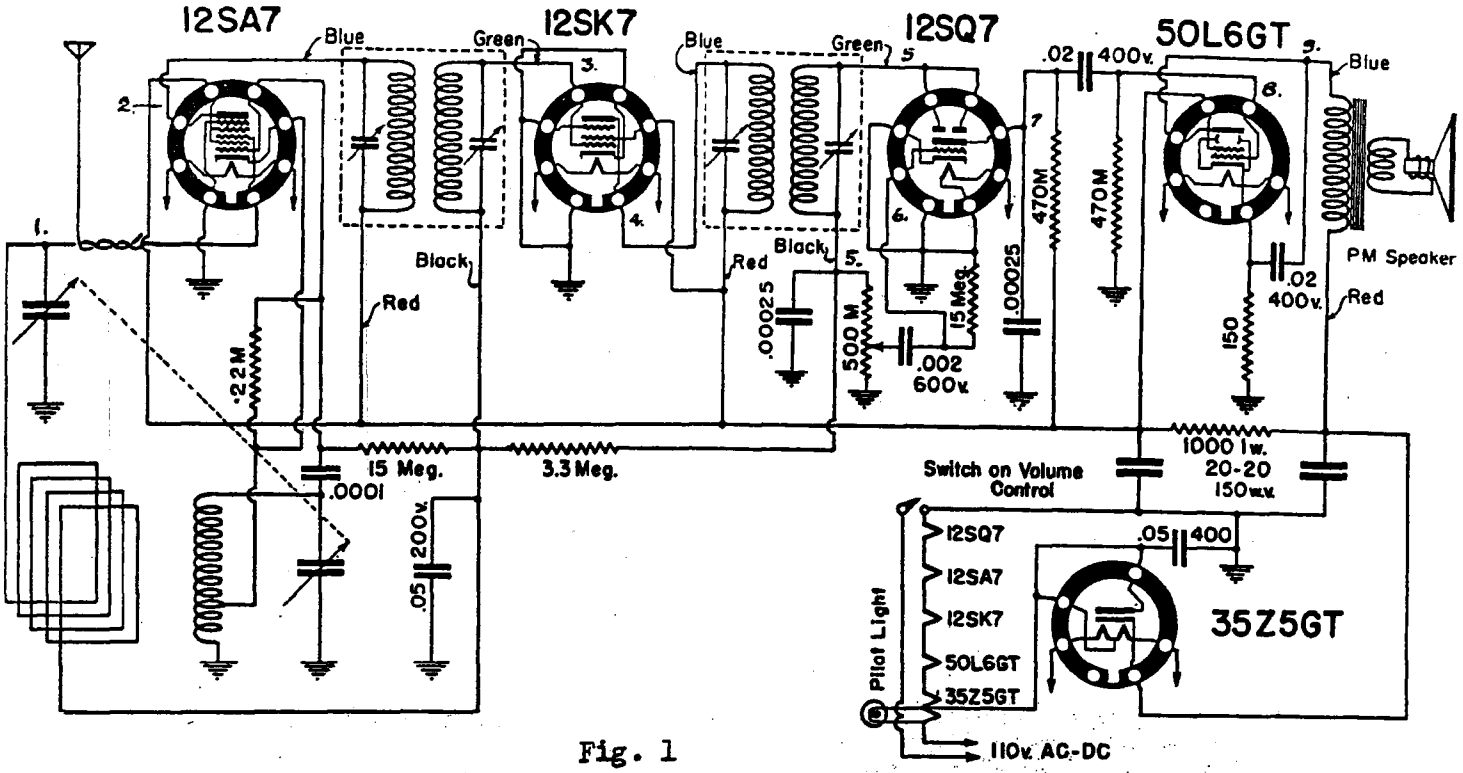

Fig. 1

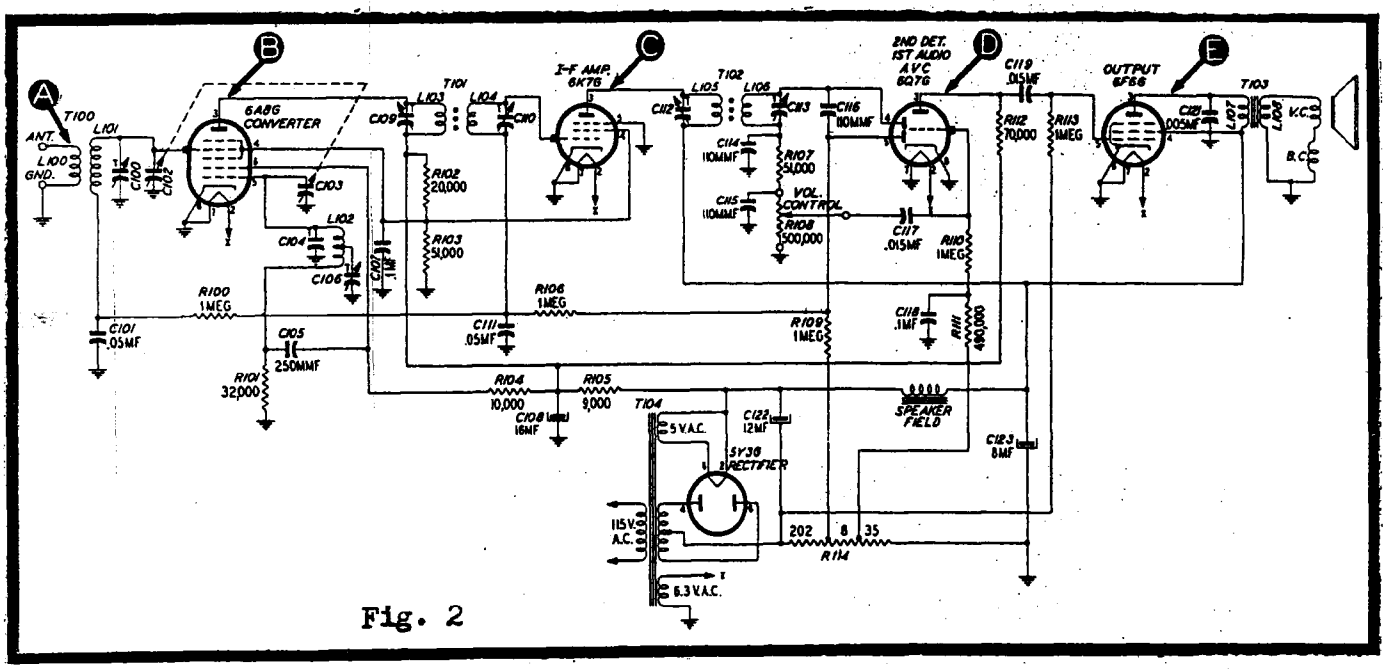

Fig. 2

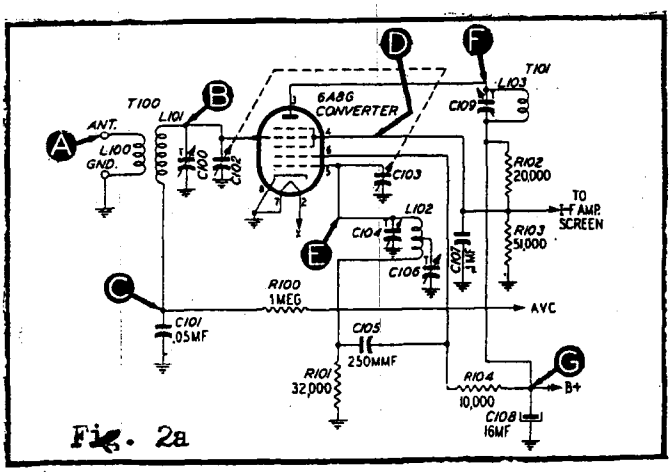

Fig. 2a

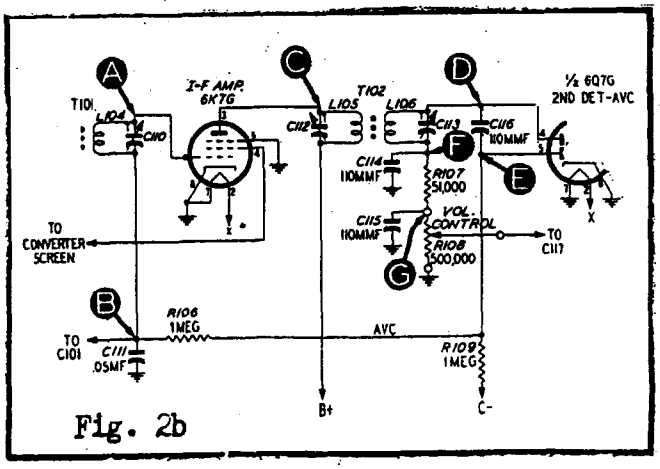

Fig. 2b

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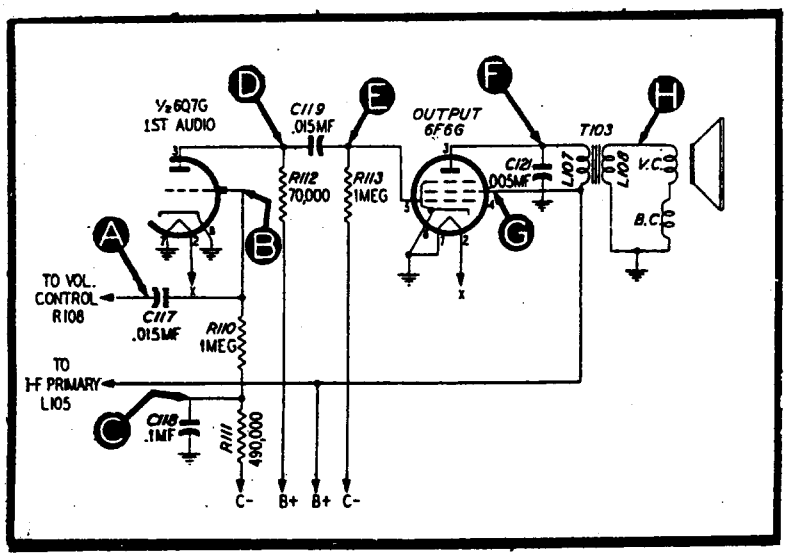

Fig. 2c

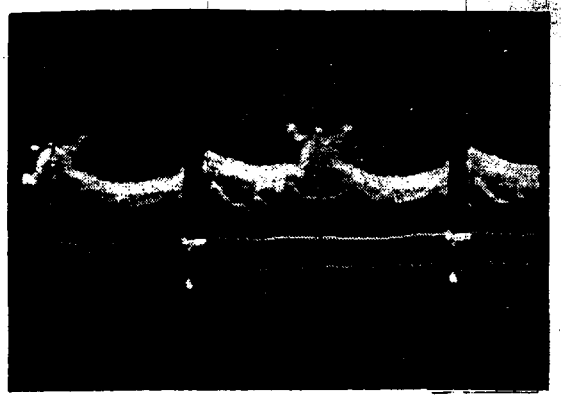

Fig. 3

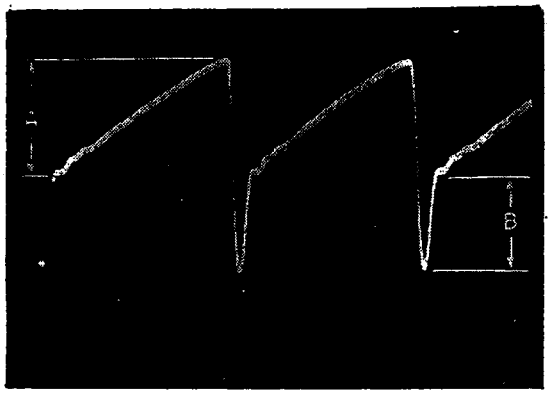

Fig. 4

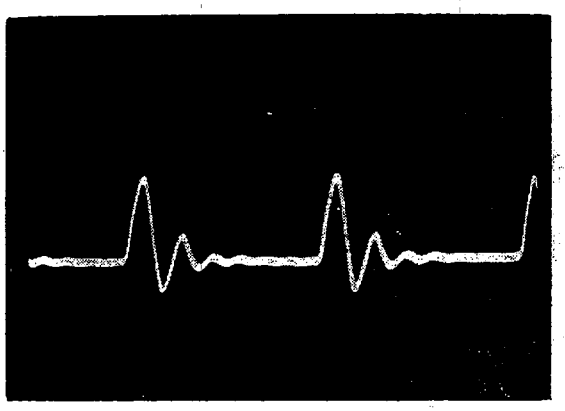

Fig. 5

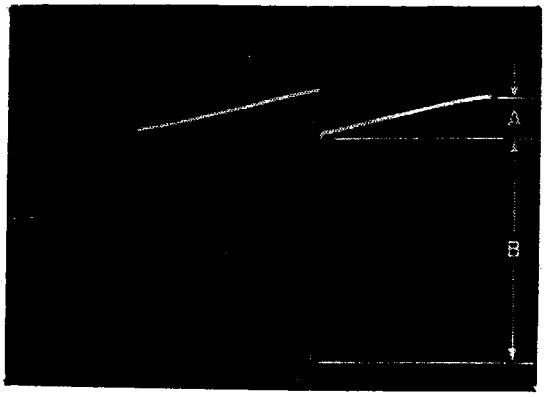

Fig. 6

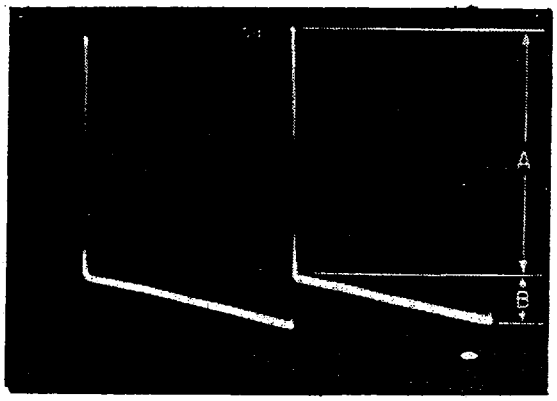

Fig. 7

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